UNIVERSITY BULLETIN
New Series, Vol. II. No. 3.
January 15, 1901.

PROCEEDINGS

Journal

OF THE MICHIGAN SCHOOLMASTERS' CLUB AT THE THIRTY-FIFTH MEETING HELD IN ANN ARBOR NOV. 30 AND DEC. 1, 1900; TOGETHER WITH SOME PAPERS READ AT THE THIRTY-FOURTH MEETING

Ann Arbor,
University of Michigan
1901

Entered at the Ann Arbor Postoffice as Second-class Matter

MICHIGAN SCHOOLMASTERS' CLUB.

PROCEEDINGS OF THE THIRTY-FIFTH MEETING, HELD AT ANN ARBOR, NOV. 30 AND DEC. 1, 1900.

MINUTES.

The thirty-fifth session of the Michigan Schoolmasters' Club was held at Ann Arbor, Friday and Saturday, November 30th and December 1st. At the opening of the session Principal J. H. Harris, President of the Club, referred briefly but feelingly to the death of Professor B. A. Hinsdale, who had been so closely identified with the work and interests of the Club, and appointed a committee to draft a memorial for presentation to the Club.

The first topic discussed was "The Newly Formulated Entrance Requirements to the University of Michigan," and the discussion was opened by Professor Richard Hudson, dean of the literary department of the University, who explained the new requirements in some detail and justified them as a step in the direction of larger liberty in preparation. The discussion was resumed by Principal J. H. Beazell, of Detroit, who, while venturing to criticise some minor details of the requirements, in the main approved of them as sound and rational.

The second paper of the session was on "The Equipment of the High School Principal," by Principal S. O. Hartwell, of Kalamazoo, a paper conceded by all to be one of the best of the session. Professor S. B. Laird, of the State Normal College, discussed the subject.

The third topic—"The Social Side of High School Life".—was treated in a very thoughtful and thorough manner by Principal R. S. Garwood, of Marshall. This paper aroused more interest than any other of the session, the discussion finally focusing itself upon the subject of secret societies in the high school. The general opinion was that these societies were detrimental to the best interests of the school, although differences of opinion arose as to the best methods of dealing with them. Professor A. S. Whitney, of the University, Superintendent H. M. Slauson, of Ann Arbor, and Principal J. H. Harris, of Bay City, were most pronounced in their

opposition, and in general believed they should be kept out of the high school. Principal A. J. Volland, of Grand Rapids, and Principal S. O. Hartwell, of Kalamazoo, felt that secret societies were matters over which the school had no jurisdiction as such, and should simply endeavor to keep them within legitimate bounds.

The Friday evening session was opened by a discussion of the question: "To What Extent Should Collateral Work in the Ancient Languages be Required?" Professor George V. Edwards, of Olivet College, opened the discussion, holding to the view that collateral work should not be directly required of the pupil, save only so much as was necessary to the correct and intelligent interpretation of the text. The teacher should have a great store of collateral knowledge which could be given to the pupil in the way of suggestion and direction, but the crowding of pupils with collateral material to the prejudice of the language study proper, was to be condemned. This topic was further discussed by Professor M. L. D'Ooge, of the University, and by Drs. Meader and Sanders, of the same institution.

The second paper of the evening was entitled "Civil Service in the Appointment of Teachers," and was a vigorous plea for higher grade teaching and for the adoption of those methods of appointment which would bring to a school the very best teaching power available. The paper was by Professor E. C. Goddard, of the University, and the discussion was led by Professor Delos Fall, State Superintendent-Elect of Public Instruction.

At the Saturday morning session the first topic considered was that of High School Statistics, Mr. D. W. Springer, of the Commercial Department of the Ann Arbor High School, contributing the paper. Mr. Springer found that there was great diversity of opinion among schools regarding the kind of statistics secured, and in many instances he found that very little, if any, statistical information was gathered. He set forth in some detail what statistics seemed to him to be of permanent worth.

At the close of the discussion of this topic, it was voted that a committee be appointed to report to the Club at the Spring meeting what statistics it would be desirable for each school to collect, and in what form those statistics might appear.

The next paper of the morning session was on the subject of "Rhetoricals in the High School," and was read by Principal E. O. Marsh, of Jackson. Mr. Marsh's general opinion was one of opposition to Rhetoricals as traditionally conducted. The results, he felt, were in no wise commensurate with the amount of energy and effort expended, and while the ability to speak before a body of people was desirable, it might better be cultivated in voluntary organizations like literary and debating societies.

In the discussion which followed it developed that most, if not all, the larger high schools had discarded rhetoricals in the traditional sense of the term, and were either doing nothing along that line, save what might be

done through literary societies, or were making it a part of the English work.

The final paper of the session was on the subject of "Physical Geography in the Program of Studies," and was by Principal L. H. Wood, of Owosso. It was a very complete presentation of the claims of Physical Geography to a place in the high school, with suggestions as to methods of teaching and a discussion of the topics that should be included in the study of the subject, and their order of treatment.

The subject was further discussed by Professor Israel C. Russell, of the University, and others.

At the business session it was moved and carried that a committee be appointed to consider the advisability of holding but one session of the Club a year. This committee is to report at the Spring meeting.

The committee appointed to prepare a memorial on the death of Professor Burke A. Hinsdale reported the following:

The Schoolmasters' Club has heard with a feeling of sadness which it cannot express the news of the death of Professor Burke A. Hinsdale, who, since his connection with the University, has been one of its most active members. His incisive and vigorous utterance, his wise counsel, we shall hear no more. The Club directs that this tribute to the memory of our friend and colleague, this recognition on our part of his wide learning, his vigorous intellect and his tireless labor for the cause of education alike in the class room and in his writings, be spread upon the minutes of the Club and communicated to Professor Hinsdale's family.

R. Hudson,
E. A. Lyman,
H. M. Slauson,
Committee.

The Club thereupon adjourned to meet in the Spring of 1901.

PAPERS.

REQUIREMENTS FOR ADMISSION TO THE UNIVERSITY OF MICHIGAN.

A PAPER READ BEFORE THE MICHIGAN SCHOOLMASTERS' CLUB, NOVEMBER 30, 1900, BY PROFESSOR RICHARD HUDSON, OF THE UNIVERSITY OF MICHIGAN.

The object of the changes recently made in the requirements for admission was to secure greater flexibility. This result has been gained in three ways. Of these by far the most important is the abandonment of the group system. Henceforward the choice is to be between subjects, not between groups of subjects. In other words, the grouping is to be done by the candidate for admission or by the school that prepares him, not by the University. The inconvenience of the group system was that a subject which might be counted in one group was not allowed to be counted in others. Neither English History nor English Literature, for example, might be offered instead of Chemistry in Group 3, although they both had a place in Group 4. Absurd as this rigidity now seems, it did not appear absurd at a time when the course taken in the High School was regarded as the necessary preparation for the course which the student intended to take in the University. A student who found that he had missed his calling might indeed be switched over to another track, but he was required in that case to make up the entrance requirements of the course to which he was transferred. We no longer think that a student should be labelled at the beginning of his High School course for some particular University degree and then carried through in bond. With the sole exception that Latin and Greek must be begun in the High School, if they are to be elected in the University, a student, once that he is admitted, may move freely in the direction of any one of our four degrees. In accounting for the persistence of the group system, it is also to be remembered that certain subjects were very late in gaining recognition, and that they might be counted fortunate in being allowed to serve a modest probation among the B. L. requirements.

The second method of gaining flexibility was to reduce the number of required subjects. Under the new system, English, Mathematics, and Physics are the only subjects absolutely required, History and Botany having been made elective. Two units of foreign language work are indeed required from all, but here a choice is given between Latin, French, and

German. The question may be raised whether the Faculty, in reducing the number of required subjects, might not have gone a step or two further. There are many who think that Solid Geometry ought not to be required. The mathematicians, however, insist that Geometry is one subject and that the study of Geometry is entirely inadequate and incomplete if it does not include Solid Geometry. There are indications that this view is going to carry the day. The state universities have generally followed the example of the University of Michigan in requiring the whole of Geometry. The University of Wisconsin and the University of Minnesota, for example, require Solid Geometry. Columbia University, which last year gave its requirements for admission a thoroughgoing revision, requires the whole of Geometry. In the old Harvard requirements, which are still in force side by side with the new, the requirement in Mathematics was Algebra and Plane Geometry. The new requirements, however, allow the candidate for admission to present either Geometry or Plane Geometry, the former counting as three and the latter as two points. The requirement in Geometry is stated and described in such a way as to raise the question whether the alternative requirement of Plane Geometry is not destined to disappear. With the Western colleges following our example and the Eastern colleges showing a tendency to fall into line, there is certainly good reason for hesitating to make any change in the requirement in Geometry. In behalf of Physics, it may be urged that an education that does not include the study of Science is antiquated, and that the study of Science ought to begin with Physics. The requirement of Physics on the part of the University has had the effect of directing the attention of the schools to a subject which they ought to teach in their own interest. Indeed, so popular has the study become that it would no doubt continue to be generally taught even if it were no longer required.

In addition to these two ways of gaining flexibility, the substitution of alternative entrance subjects for alternative groups and the reduction of the number of required subjects, a third method remains to be mentioned. The new entrance requirements take a modest step in the direction of the recognition of new subjects. Zoology takes its place by the side of Botany as an entrance elective. Students who present neither Botany nor Zoology may, if they desire, present a year's work made up in part of Botany ana in part of Zoology. Physiography has also been placed on the list of subjects which may be counted for admission. The work that must be done in these subjects, if they are to be counted for entrance, is described in a leaflet published by the University. The question is sometimes asked whether the work in Physiology now done by the schools may be presented instead of Botany. To the question in this form the answer must be in the negative. It is, however, another question whether a course could be mapped out that should include the Physiology and Hygiene which the schools are compelled

to teach and which should at the same time be so scientific in character as to entitle it to recognition as an entrance elective. Perhaps a solution of the problem may yet be found. Those among us whose opinion is most worthy of attention think the thing is not feasible. Harvard, however, in its new requirements recognizes a year's work in what it calls Anatomy, Physiology and Hygiene.

In making the changes that have been described, it was not the intention of the Faculty to increase the requirements for admission. Inasmuch as Botany was made an elective, it was clearly necessary to increase the requirement in that subject from a semester to a year in order that it might have equal value with the subjects with which it was made interchangeable. The time assigned to Mathematics, three units of four periods a week, is slightly less than the time now generally given to the subject, five periods a week for two and a half years. It was not easy to decide how many units to assign to English. In fixing the number at three, the Faculty was guided by the consideration that the stronger schools were already giving to the subject an amount of time equal to two years and a half at five periods a week, or three years at four periods a week, and that if any change was incidentally made it should be in the direction of increasing rather than of decreasing the English requirement. In defining a unit as a subject pursued for four periods a week throughout a school year, the Faculty merely sought to indicate the amount of time that must be given to a subject if it is to be counted for admission. There was, of course, no thought of bringing a pressure to bear on the schools to induce them to adopt the four period system, but rather a recognition by the University of a tendency in that direction on the part of the schools. The three units of English required may be spread over four years of three periods a week, just as the requirement of three units in Mathematics may be met in two years and a half if five periods a week are given to the subject. The definition of a unit as four periods a week more than counterbalances any increase in the requirements in Botany and English. The amount of work required in Latin is, for example, reduced as a result of this definition by three books of Virgil.

Attention may be called in this connection to a peculiar feature of the requirement in English. It is indeed a requirement both in Composition and in Literature, as the description of the work required plainly shows. These two subjects ought to be studied in parallel lines from the beginning to the end of the course. If this is done, however, where is the line to be drawn between the three units of English required from all students and the year's work in English literature that may be offered as an entrance elective? It is clearly unsatisfactory to say that the study of a brief sketch of the history of English Literature constitutes the difference, for such a study may form part of the three units. Or is the question whether the credit is to be three or four units to depend on the amount of time given to the sub-

ject? To make credit depend mainly on time is far from an ideal arrangement. Some answer must be found to this question if candidates for admission are to be allowed to count English Literature as an elective unit over and above the three units of English that all students are required to present.

The conservative character of the changes described in this paper may best be brought out by calling attention to the fact that with the sole exception of the increased requirement in Botany, and possibly in English, the old groups fit into the new system. They are but a few out of the large number of combinations that are now possible. The decisive fact is that the schools, in preparing students for the University, are no longer limited to these particular combinations, but may freely choose from a fairly large list of subjects, provided only they meet a few fundamental requirements. The group system was a standing temptation to the schools to scatter their energies by preparing for as many courses or groups as possible. There is no reason why every school should teach all the entrance subjects or why every school program should be the duplicate of every other. Individuality is as much to be desired in schools as in persons. Local conditions and the qualifications of the teaching force ought to be important factors in shaping the school program. Concentration upon a relatively small number of subjects explains as much as any other one thing the strength of the A.B. course. The chief defect of the old B.L. preparation was the fact that it was made up of a large number of subjects pursued for the most part for but one semester. Much has already been done to remedy this evil, and no doubt the improvement will be still more rapid now that the schools have greater freedom to choose their own line of development and are under less temptation to multiply courses. As the schools grow the number of subjects which are studied for a period of two or more years will no doubt increase. As advanced work comes to be done in new lines, it will find a place among entrance electives. How far the work of the schools shall be elementary and how far advanced is, however, a problem which the schools themselves must work out. The high rank of the Michigan schools is no doubt due to no inconsiderable extent to the stimulating guidance of the University. But the University, in its relation to the schools, has never lost sight of the fact that they have a life of their own, which it may indeed foster but may not mar.

THE EQUIPMENT OF THE HIGH SCHOOL PRINCIPAL.*

PRINCIPAL S. O. HARTWELL, KALAMAZOO.

The topic is one in which most of us are directly interested, and upon it all of us are likely to have definite views. The opportunities that it gives for cataloguing our virtues or dissecting our faults I shall hope to avoid, for the sake of limiting the discussion to a few points in the professional equipment of the high school principal which seem to me to have become essential.

A few years ago any consideration of this subject as distinct from the general fundamentals of equipment requisite for all secondary teachers would have seemed academic rather than practical. Few will so regard it now. The march of events has raised our public high schools to a position of greater importance than ever before. Their growth in the last ten years is too well known to need description. In the North Central states the enrollment in public secondary schools, in the year 1890–91, was a little over 104,000; in 1898-99 (the latest figures obtainable) it was as much over 242,000. In the same way the amount and character of the work done has been strengthened in the last decade. The change in the last thirty years has well nigh amounted to a revolution. And the trend of progress seems to denote a farther advance. The changes incident to this growth and improved organization have naturally brought to the principal increased labor, but they have enlarged his opportunity and his responsibility as well. The difference in degree is becoming a difference in kind until to the native ability supposed to be found hitherto in public servants of this class there is now added a demand for professional training but lately unheard of. The post has become a professional one, and the principals themselves should be the first to recognize the fact. To do so is not to magnify one's office—rather failure to do so means the acceptance of too low a standard.

The daily problems of the principal of a large school are, to some degree, comparable to those of the executives of the higher institutions; the difficulties in a small school are sometimes even more acute. In the high school the question of the adjustment of work to the pupil, of the pupil to his work, and of different departments to each other, bring problems as perplexing and varied as those found at any stage of the pupil's advancement. These have lately increased by the broadening of courses and the extension of the elective system. To meet them successfully a man must either have great ability, or a training that shall equip average ability and judgment to do efficiently a highly organized work. Brains are fairly plentiful, but talent is not sown broadcast. Brains, then, developed by good

*Read at the meeting of November 30, 1900.

training, must always be looked to meet the requirements of this profession, as of all others.

This fact is not new or striking, but its immediate application seems not fully perceived except in the pedagogical departments of our universities. If it has reached the other departments it hardly influences their action. Hence it is generally appreciated by candidates looking forward to this line of work, and, quite naturally, by school boards in search of candidates—if they ever have to search for the omnipresent.

Under our present organization the principal is a specialist. But if I may start with a contradiction, that is just what he may not be, at least as the term is commonly used. The specializing that will best prepare him for work will include a training of executive power and of judicious sympathy; a study of at least two divisions of the educational field, the one in which he is to toil and the one just below; and as well the broadest possible scholarship. Captain John Bigelow, in his interesting book on the Santiago campaign, advocates a general staff which shall oversee and regulate the various war bureaus. This, he claims, is necessary if war scandals, such as lately disturbed and wearied us, are to be avoided in future; and he describes the men required as "specialists in specialties." The phrase may be transferred to the description of the high school principal. The training that will secure this kind of equipment comes very near the old idea of general culture.

For many moons scholars have been arrayed under the two banners, classical and scientific. The field of knowledge has other divisions, but, from the nature or method of their work, most intellectual workers have been content to be placed in one of these classes. It is not necessary to recall the antagonism between them that has sometimes made them appear as hostile camps rather than co-workers for righteousness. In the places where we ought to hope for broad sympathy with intellectual advancement, whatever the path, there has too often been unseemly quarreling over leadership and relative value. The effect on the school has been bad, through false training of their managers-to-be. Too many college departments have been interested in securing (i. e., in training) partisans rather than intellectual patriots. Having found a youth with interest and preference for their chosen line, they have tried to foster those qualities by the process of exclusion. Then they have been active, sometimes officious, in getting for this product a position to teach—which is all right; or quite as likely, a place as principal or superintendent, where he is expected not only to teach but to arrange his dominion, large or small, around the pivotal Latin or the pivotal science, as the case may be—which is all wrong. I do not think this tendency so marked now as it has been; nevertheless, it is still too prevalent and influential. Its bad policy, from the college view-point, might be shown. Its effects on the schools are injustice and deformity.

Such training may do (would it were more often supplemented) for the special teacher; it will not suffice for those who hope, as principals, to influence school policies or to direct the activity of a hundred or hundreds of children of many minds, different temperaments, and widely varied conditions of life. In the sense described, the high school principal cannot afford to be, has no right to be, a specialist. He needs the broadest intellectual equipment he can secure, coupled with a working knowledge of scientific methods. I would not be misunderstood as in any sense undervaluing scholarship or even special proficiency in one field. A specialty—retaining the word's general usage—need not be in the principal's way. He may if he is strong enough make it his most useful ally. But to meet his full opportunity he must be able to make it a point of departure rather than his centre of energy, to use the precision and method gained from it for attacking other fields, until he shall at least have surveyed their outlines and secured a point of view. Classical students, scientific students, students of history and literature ought to make equally good principals, if of similar ability. But they must break away from traditional theories as to relative values, and so broaden their intellectual sympathy as to be able to appreciate the worth of all honest intellectual effort. If I mistake not, it is toward this end that the best departments of pedagogy are now directing their training. But too often they seem to be striving single-handed against the current of influence in other departments. Practically the case reduces itself to this; he who is now preparing for the broader lines of teaching should look to the pedagogical department for inspiration and direction of work, to the others for all he can absorb during the years of his course.

There are, naturally, practical considerations that limit somewhat the relative value of the different lines of preparation. It is still usual for a principal to remain in charge of one department in addition to his general charge of the school. When this is so the conditions seem to me to put the heaviest handicap upon the scientist Experimental work and preparations for it are heavy consumers of extra time. Regarding the inherent possibilities of producing power, I believe, too, that the student of history and literature—whether the latter is ancient or modern, English or Greek—has the greatest advantage. These studies deal most directly with human nature as exhibited individually or in the mass. But that is beside the question. To make the first essential in the choice of a principal the fact that he is a classicist or a scientist is folly. Yet many boards still do this and are encouraged to do it. The prime requisite is scholarship vital enough to continue its growth; a scholarship that will not degenerate, that has not degenerated, into scholasticism.

Political conditions in Asia and Africa have developed in the last few years certain nebulous governments called buffer states. Through these

the European powers have tried to protect, by separation, their stronger spheres of influence. The principal's position as a harmonizer of different departments reminds one of these artificial political creations. But if schools lose equilibrium the immediate disaster to students is greater than when colleges become lop-sided: Hence the principal must be actively a director as well as a buffer, and hence, again, we come to the necessity of broad preparation and a wide outlook.

The mass of executive work in our schools is growing yearly. Few outsiders realize its amount, though every one admits the need of strong executive ability in the principal. Practically, I think, more can and should be done for training this power than has been hitherto. Some may object that executive ability comes by the grace of God—one has it or has it not, and training is superfluous. The same thing might be said of scholarship, but would hardly be accepted as an argument.

The need for a thorough study of education is just as clear. The opportunities to secure it are ample. One point only has to be emphasized. One who wishes now to do good work in a high school must give careful study to the grammar school department. I venture to say that lack of accurate knowledge of the conditions and character of the work of the grammar grades is the greatest fault of the present generation of high school principals. The failure to co-ordinate the departments is shown by the proverbial gap between the grades and the high school, that chasm of discouragement and failure which swallows so many pupils. This fault does not lie wholly with the grades, any more than the former hiatus between school and college lay altogether upon the high school. For some years the high school and its problems have received the earnest attention of educational leaders, and particularly of college authorities. Those who have known most of our conditions have done us the most good. The far-away, censorious criticism of those who have not taken pains to observe has been alike futile and irritating It is but repeating a commonplace to say that the present field for fruitful labor is in the grammar grades. The bridging of the gap just mentioned rests as much with the high school as with those below. The principal's responsibility is established. The measure of success in his own department is likely soon to depend closely on his intelligent helpfulness in solving these grade problems. At present he is too apt to dismiss them as unimportant or beyond his sphere.

I have mentioned among the requisites of a principal a trained sympathy—trained sympathy because training gives control, and of all things he should avoid the unbalanced kind that ends in gush. In Elbert Hubbard's essay on Joseph Addison he gives the characteristics of a gentleman as sympathy, knowledge and poise. "Poise," he goes on, "is the strength of body and the strength of mind to control your Sympathy and your Knowledge. Unless you control your emotions they run over and you stand

in the slop." This sloppy kind too often stands in mind for all sympathy. It is certainly one of our great modern nuisances, and the average man of education needs no warning to shun it. The danger for those of our calling lies most often in the other direction. While it affects all teachers, its influence on the principal may be most harmful. Executive detail, steadfast application to intellectual work beget interest in work or in a given subject for its own sake. They tend to exclude the living interest essential to success and preventive of fossilizing. The living and lively factors of our daily problem come to be simply factors. The specialist may forget that pupils, not studies, are to be taught; if the principal also disregards that fact the effect on the school is soon deadening.

The largest training of this power must come through experience. But experience, carelessly left to its own course, brings so many temptations to repress sympathy, so much devitalizing detail, that it seems to me the principal ought at the outset to put before himself the absolute necessity of retaining an interest in his pupils as reasonable human beings, and constantly correct his steps thereby. It is doubly hard from the fact that one must deal with immature minds, whose potential is easily obscured by present crudenss. But he who loses this sympathy has entered on the first stages of that creeping paralysis that benumbs so many "old stagers." Sympathy is not all. Most emphatically the gospel of work is to be the salvation of our schools. But rightly interpreted that gospel lies in rousing the individual to stronger effort by fitting work to immediate conditions. This can never be done unless quick, though well-poised, sympathy is added by those in charge to the careful study of conditions.

There is room in the principal's profession for the highest genius and virtue. Just as elsewhere, that room is oftenest unoccupied. But there is and always has been a supreme test of fitness—sincerity of character and purpose. Given that (and there is no cause to be ashamed of the way it has been met), it seems to me that any man may compel success if he fairly views and tries to meet the professional requirements. These, I have aimed to show, demand culture, which Charles Dudley Warner has called, "That fine product of scholarship and opportunity to which learning bears the same relation that mere manners do to the gentleman." They include trained administrative power, trained sympathy. As the field grows and the demands of the principal's position increase, even genius and virtue will halt wearily unless strengthened by such equipment. With it the average man is ready to meet the daily broadening opportunity.

THE REPORT OF THE COMMITTEE OF TWELVE ON COLLEGE ENTRANCE REQUIREMENTS IN GREEK.*

PRINCIPAL J. H. HARRIS, BAY CITY, MICHIGAN.

In the discussion of a report like the one indicated in the title, prepared with such laborious care and in such a thoroughly scientific spirit, it is hazardous and possibly presumptuous to indulge in criticism or question. The character and ability of the men who constituted the committee—sufficient in itself to lift it above the plane of petty and amateurish criticism; the unstinted toil expended in gathering, arranging and interpreting the material accumulated in the process of preparing the report; the endless pains taken in correcting, revising and testing every assertion formulated and every conclusion reached,—all combine to give the report a dignity, a significance and a value which has attended no secondary report since the report of the Committee of Ten. And it may be seriously questioned whether an exception may be made of that.

Commendation, therefore, is almost the only recourse left to one seeking to discuss the report or aiming to give something more than a resumé of the material contained in it. And to be reduced to the barren and profitless task of summarizing what some one else has said is neither complimentary to one's critical faculties, instructive to one's readers nor auspicious for the future of the cause. Finality in anything is to be deplored—most of all in education.

And so, while admitting the very great value of the report and while voicing the most thorough-going appreciation of its almost unvarying merit, it would be cause for regret if all its conclusions were so universally accepted and so irrefutably established that there was nothing more to be said. For myself I do not care to be lulled to dreamless and eternal sleep —like the Lotophagi—"no more to think or work or do," even though it be at the hands of the Committee of Fifteen or the Committee of Twelve.

It is not my purpose in this article to discuss the report of the Auxiliary Committee on Latin Courses in the secondary schools; that report has been already discussed by others. The report of the Auxiliary Committee on Greek has not, however, been accorded the special consideration which its importance deserves; and that, too, though it is the most vulnerable of the two reports.

The preparation of the Greek program presented to the committee a comparatively simple problem, first, because the amount of Greek literature suitable to preparatory work is limited and, second, because the problem had been much simplified by the discussions and report of the Greek Con-

* Read at the meeting in November, 1899.

ference of the Committee of Ten, by the Commission of the New England colleges and by the Greek conference held at Columbia in the spring of 1896. The committee was unanimous in reaffirming the position taken by the Committe of Ten, and proposed a program which is in essential agreement with that of the Commission of New England Colleges and the Columbia Conference of 1896.

The committee makes six recommendations: First, as to Time: that three years be devoted to study of Greek in preparatory schools; second, as to Grammar: that a thorough and methodical study of Greek grammar go on *pari passu* with the reading of literature, so that the pupil may be thoroughly grounded in forms and syntax and that he be made so familiar with the order of presentation of the various topics in the grammar that he may be easily able to find the information for which he must be constantly seeking.

The third recommendation has reference to the instruction in Greek Composition, and urges that it be carried on from the beginning, with special attention in the third year. For this the familiar and conceded reasons are given: that it fixes the pupil's vocabulary, that it serves as a constant review of the Greek forms, that it quickens his sensitiveness to the peculiar significance of the order of words in the Greek prose sentence and to the fine distinctions of meaning between similar words and constructions, that it serves as a check to carelessness and that it tends to accurate scholarship. The reason why the committee lays special stress on the study of prose composition during the third year, when Homer is read, is that the pupil may preserve that familiarity with Attic forms and constructions which is essential to satisfactory work in college. The committee strongly recommends the method known as retroversion, that is, the re-turning into Greek of the English translation of some Attic prose which has been read by the student. The systematic presentation of Greek constructions in text-books prepared with no reference to a special text is also insisted on. The committee regards a combination of the two methods as desirable—a position which the writer of this article advocated in the *School Review* in the issue of June, 1894.

In the third recommendation, the committee advocates continued practice in sight-reading, holding that it is not only desirable from the pupil's point of view in gaining a mastery of vocabulary and a confidence in his powers, but is of the utmost importance to the teacher in enabling him to detect the pupil's difficulties and weaknesses.

Reading Greek aloud is the next recommendation of the committee, and insistence is laid on securing the right quantity of the syllables.

Finally, as to what shall be read, the committee realizes that there is nothing more suitable and better adapted for second year reading than Xenophon's Anabasis, even though it may not be purest Attic. For the third

year the committee recommends that Homer be read, and while admitting that from one point of view the study of Attic prose ought to be continued through the entire preparatory course, yet, for the sake of those students who take Greek only in the preparatory school and do not intend to go to college, and as well also as an inspiration to those who are to continue their studies in college—giving them an enticing foretaste of what is ahead—the committte recommends that Homer be read through the entire third year.

In discussing this report—so complete, so suggestive, so scientifically developed—it seems to me there are only two points on which a difference of opinion can possibly exist. These are, first, the question of the amount of time to be devoted to Greek in the secondary school, and, second, the question of the reading of Homer. On all other points there can hardly be other than complete unanimity of opinion. With the committee recommendations regarding grammar, composition, reading aloud, sight-reading and reading material, all teachers of Greek would be in hearty accord. They set forth clearly and conclusively the essential characteristics of the preparatory instruction in Greek. Providing also a three years' course is predicated, I believe the recommendation of the committee as to the reading of Homer is based on sound and convincing grounds and would meet with no serious dissent. The reading of a portion of Homer is eminently desirable provided enough time can be given it to make it of real worth. If it is to be crowded in during the last six or eight weeks of a two years' course, then the advisability of reading it may well be called in question. The whole discussion, therefore, sifts down to the the one problem of Time: in other words, to the recommendation of the committtee that three years' time be devoted to the study of Greek in the secondary school. In discussing the point I shall aim to look at it largely as a practical problem in school administration from a secondary point of view. I realize full well, how, from the University point of view, three years' preparation in Greek is eminently desirable and urgently advocated. It is to the interest of the college and university that its matriculates come up with as large and advanced a preparation as possible. From the point of view, too, of the specialist in Greek, the requirement of three years may logically be urged. To him Greek is the *sine qua non* of a finished education, and the more of it that can be had the better.

But besides the view-points of the college and the Greek professor, there must also be taken into consideration by those who have courses of study to construct, the large and constantly increasing number of interests which a secondary school has to conserve. A public high school particularly must have due regard not alone to those claims and demands which spring from above, but as well to those who support it and who demand its privileges for every legitimate and properly accredited branch of instruction. In saying this I do not mean to intimate thereby that the public in general

is hostile to Greek. I do not think it is, only I think it feels that Greek should not exact more than its fair share of the time and effort of the school, to the prejudice of other studies that may have equal value for life. And with the present multiplicity of studies and with the present insistence which each department of thought and scholarship is placing upon the worth and importance of its specialty, the only possible course for the administrator of school programs is that of the conservative and judicial arbiter who serves as a mediator between the people clamoring on the one hand for the practical and utilitarian and the university specialist on the other calling for an ever increasing share of time for his particular interest. Years ago when the range of secondary studies was comparatively limited, when Latin and Greek constituted not only the backbone but the very body and substance of the course; when the sciences received only the minutest fraction of the time or attention now devoted to them; when English, as a branch of instruction, was only a child in swaddling clothes compared to its present stage of growth and development; when history had not attained nor even aspired to that dignity and importance which its merits deserved and its value justified; when even mathematics, that staid and substantial child of the ages, was content with a more modest portion of the educational menu; *then,* I say, it was not so difficult nor so impracticable to give Greek the three years' time which its friends felt that it deserved. But the question of how much time is to be devoted to Greek in the secondary school is not solely nor even primarily an academic question, to be solved only in the study of the Greek enthusiast. It is a very practical and every-day question of time, teachers, expense and a due regard for all the interests which go to make up a thoroughly modern school. Nor is it a question of the educational value of Greek. Admitting all that may be said in behalf of Greek as an instrument of discipline and culture—and as a teacher of Greek I should be the last to call these in question—it still would be true that one might fairly raise the query whether, under existing conditions, the recommendation of three years' preparatory Greek is not an error in judgment, and whether it would not have been much better for the cause of Greek if only two years had been called. The demand for three years can hardly fail to arouse objections and antagonisms. The demand for two years would have been met with friendliness and favor. With so many subjects pressing upon the pupil's time and attention, competing for his favor, it is hardly fair that more than two years of his preparatory school time be given to Greek. If he desires further acquaintance with it or discovers in himself linguistic capacities, the opportunity for further and more specialized study will be furnished in the university or college.

But the conditions of modern life are so complex that he who has developed one set of reactions at the expense of the other finds himself at a disadvantage. He is not prepared to meet life on all sides. The adjustments

necessary to the complete and intricate environment in which we find ourselves are so nice and precise, that it demands the most careful thought to attain the right end and the right results from our educating process. If the biological conception of the nature of education is the sound and accepted one, and if it is the function of education to enable us to react more effectively and accurately upon our environments, then the time-element in the claims of any particular study calls for the most rigid and searching investigation. And the specialist is in some respects the least competent to pass judgment upon it! Just what educational value a study has in the process of mental development; just what amount of time is necessary to give it its full value; just where to draw the line between the extravagant and exuberant claims of friends and the no less exaggerated and unreasoning antagonisms of enemies; these are nice questions of the law, and call, not for the partisan, but for the judge. Greek has its distinct and undeniable educational value. It is not necessary to enter upon an argument for its worth or to give expression to the reasons which justify its place in the secondary program. But whether the value and the function of Greek may not be equally subserved, nay, even more surely and permanently subserved, by putting forth the very modest and legitimate claim of two years of preparatory study, is a very interesting and possibly a very crucial question. For while the claims of Greek to two years' time might not be called in question nor antagonized, the claim of three years, by its dangerous proximity to selfishness, might lead to opposition and even a denial of its more moderate and wholly reasonable rights and privileges.

And so, from the point of view of a secondary school program, already gorged with a superabundance of studies; from the point of view of a classical curriculum wherein the requirements in Latin and Greek are becoming more and more extensive and exacting; from the point of view of a riper and more modern conception of education in which science, history and English are calling for a just recognition of their claims, and wherein modern political, social and religious conditions are recognized as so radically different from those of fifty years ago as to demand, a system of education essentially different both in form and content; from the point of view, finally, of the interest and future of Greek itself, I must venture to regret the action of the committee in restricting itself solely to a course of study covering three years. The least that it could have done would have been to outline a course covering three years, as did the Latin committee in the six-year and the four-year courses. For it certainly is true that a very large number of schools can give only two years to Greek, and for their benefit and guidance a two years' course should have been laid down. It is a little difficult to appreciate the reasons which prevented the committee from preparing such a course, but inasmuch as it was not done, the work of the committee can hardly be looked on as other than incomplete.

PHYSICS CONFERENCE.

MARCH 30, 1900.

ELECTRICAL MEASUREMENTS IN THE HIGH SCHOOL LABORATORY.

BY C. F. ADAMS, DETROIT, MICH.

It is embarrassing to attempt to treat such a broad subject as this in the few minutes at my disposal. I can only attempt in a very general way to state what quantitative exercises in electricity seem to me best adapted to the high school and to indicate the apparatus best suited for such exercises. I do not wish to be understood as saying that those I recommend are the only exercises in electricity and magnetism to be attempted, but they seem to me about the only ones in electrical measuremnts well adapted to the high school. The list I would recommend is as follows:

(1) The Determination of the Constant of a Tangent Galvanometer by a Gas Voltameter.

(2) Measurement of Electromotive Force of Cells (single cells and cells joined in parallel and in series).

(3) Ohm's Law:—Fall of Potential Along a Conductor.

(4) Resistance of Wires by Wheatstone Bridge,—verification of law of length, law of diameter, and law of shunt circuits.

(5) Resistance of Cells, only non-polarizing cells, such as the Daniell or gravity, being used.

Equipment:

1.—A tangent galvanometer.
2.—A telescope and scale.
3.—A bracket to support telescope and scale.
4.—Two Leclanché cells.
5.—Four Daniell cells.
6.—A D'Arsonval galvanometer.
7.—A commutator.
8.—A resistance box.
9.—A 5,000 ohm coil.
10.—A Wheatstone sliding bridge.
11.—A burette.
12.—Two platinum electrodes.

13.—Sundry supplies as follows: Several spools of copper wire of known length and diameter, ¼ oz. No. 40 copper wire, ½ lb. bare German silver wire No. 24, a soldering outfit, ability to use a few tools, and, lastly, abundance of perseverance and patience.

Such an equipment as this will provide for a large amount of substantial laboratory work and will cost about $25, though a considerable part of this sum can be saved by the teacher if he has some mechanical ability or if he can enlist that of his pupils in his service.

I have placed in the list a tangent galvanometer which for general electrical measurements is considered by many to be out of date. My own experience leads me to prefer the D'Arsonval, with telescope and scale, for nearly all of my work. However, I have found no exercise in electricity more instructive and interesting to the pupil than that of finding the constant of a tangent galvanometer by means of a voltameter. I recommend this exercise for its own excellence. It is not necessary for one to spend very much money for a tangent galvanometer. Almost any physics class will furnish one or more boys capable of making a fair instrument, and one that may be used for the other exercises if found necessary or desirable. A burette placed over the negative electrode makes an excellent voltameter, and the resistance of the circuit can be controlled by raising or lowering the burette about the electrode.

The D'Arsonval galvanometer, when a resistance of 5,000 ohms or more is joined in series with it, practically becomes a voltmeter, and with the telescope and scale arrangement the deflections are proportional to the current or to the electromotive force. Hence by comparing deflections, the electromotive forces of cells and batteries can be compared and the fall of potential along a conductor can be determined. One or two ounces of No. 36 German silver wire will make a high resistance coil to be used with the galvanometer.

The D'Arsonval galvanometer should be placed on a bracket on the wall near the window, or on the window sill itself. In the latter case a screen must be placed back of the instrument to shut out the direct light from the telescope. The telescope and scale should be supported on a bracket about 30 inches long. Any blacksmith can make an excellent bracket for this purpose out of wrought iron. If the building be of brick, the galvanometer so placed will generally be free from vibration due to walking about the laboratory or jarring of tables. Telescopes that can be bought at prices ranging from 99 cents to $2.50 can by slight modifications be made into quite good reading telescopes.

The ordinary cheap resistance boxes commonly sold to high schools are far from satisfactory. For my part I do not appreciate the fractional ohm coils placed in them. I should think manufacturers might substitute for them about three 2,000 ohm coils at no additional expense, since these need

not be adjusted at all accurately to any fixed value. Plug resistance boxes costing only a dollar or two more than the common form are now in the market, and are much to be preferred. To be sure they are not very accurate, but the several coils do not constantly vary in value whenever a new adjustment is made. I would suggest that some teachers might make it a part of their summer school work at the University to adjust and correct such a resistance box. Possibly the department of physics might find it feasible to have students test and perhaps adjust resistance boxes for such high schools as choose to send them to the University.

The other items of the equipment need little comment. I might say that the No. 40 wire is intended to supply suspensions for the coil of the D'Arsonval galvanometer. Time does not permit me to go further into detail in regard to the several exercises, and it would not be very profitable for us without the apparatus itself before us to make what I might say interesting and clear.

QUANTITATIVE WORK WITH THE INCLINED PLANE.

BY C. S. COOKE, DETROIT, MICH.

Not being satisfied with the discussion of the inclined plane as it was left at our last physical conference, I determined to submit some data taken by our pupils recently to show that it is possible to get results considerably within one per cent. of error as against the two or three per cent. set as the limit last year. It is my purpose also to speak of certain difficulties we have encountered in this experiment, and to tell how we think we have overcome them.

First, I wish briefly to outline the experiment as it is performed in our laboratory. The apparatus consists of a smooth board four or five feet long by eight inches wide, arranged with one end elevated above the table and slightly projecting, so that a scale-pan attached by a stout cord to a four-wheeled car may rise and fall freely by the end of the table while the car rolls up and down the plane. The cord of course passes over a pulley clamped to the end of the board, which is so arranged that the cord will be parallel to the plane of the board. The weight of the scale-pan is taken, and that of the car, together with its load. Then the vertical rise of the plane per 75 cms. of its length is measured. To accomplish this, a meter-stick with a straight edge is placed on the plane and slid down until its end just touches the table, when 75 cm. mark is noted. The vertical rise needs to be measured with considerable care. Half a meter-stick mounted on a suitable base will be useful for this. The pupil then finds by trial what weight in the pan is necessary to pull the car up the plane with uniform speed after it is

started. In a similar way the weight in the pan that will allow the car to roll down the plane is determined. In each case the average of several determinations is taken. Assuming that the friction is constant, it can be eliminated by taking one-half the sum of the weight in the pan, together with the weight of the pan. This would be the force necessary to balance the car and its load, if there were no friction. If the ratio of the length of the plane to its height equals, within reasonable limit of error, the ratio of the weight to the effort, the pupil can say that he has verified the law of the inclined plane.

When we first began to perform the experiment, the cars gave considerable trouble. Adjustable cars that give entire satisfaction are now common. Our greatest difficulty has been in securing suitable planes. All that we have had any experience with have twisted out of shape. We have tried different kinds of wood, but always with the same result. Such has been our experience the past three or four years. Last fall strips of plate glass were obtained and placed on the planes, and now all our difficulties along that line have vanished. The delicacy is also very much improved, for two or three grams either way from the correct weight in the pan are enough to make the car depart from uniform motion. Despite the improved plane, our results were not what they should be. It was suggested that perhaps the tables were not level. A carpenter's spirit level was obtained, the tables readjusted, and now everything works well. The following data will show the effect of working on an uneven table:

Weight of pan	70.5 grams.
Weight of car and its load	1405 grams.
Vertical rise of plane per 75 cm. of length	32.4 cm.
Pan, plus weights, car going up	645.5 grams.
Pan, plus weights, car going down	558.5 grams.
One-half the sum	602 grams.

$$\frac{L}{H} = \frac{75}{32.4} = 2.315$$

$$\frac{W}{P} = \frac{1405}{602} = 2.333$$

These ratios show a variation of approximately 18 parts in 2,000, or .9 of one per cent. When the level was placed on the table, it showed that the vertical rise was too great by .3 cm., or 32.1 cm. for the correct vertical height; 75 divided by 32.1 gives 2.336, a variation of a little over .1 of one per cent.

Let us inspect the results exhibited in the table on the following page and see what conclusions may be drawn.

I wish to call attention to the fact that these are not selected results, but the actual work of all the pupils. The different groups represent the work done by different pupils on the same piece of apparatus. In only one case is the variation greater than one per cent. In this instance it is apparent

that the pupil has made a mistake in counting the weights. I found the average error of the class to be one-third of one per cent.

Notice that the weight in the pan does not vary greatly.

It may be interesting to notice which factor is the most liable to error. I think it will be granted that it lies between the measurement of "P" and "H." Take, for instance, the results at table No. 6, in which the vertical rise is 33.3 cm. in one case and 33.4 cm. in another. Comparing 2.252 with 2.246, we see there is a difference of .006. Take the third and fourth results, in which "H" remains the same and in which "P" varies by 5 grams. Here we have a difference of .013. This means that an error of 1 mm. in the vertical rise is equivalent to a mistake of between two and three grams in the pan. All things being considered, it is a great deal easier to make a mistake of 1 mm. in measuring the vertical rise than it is to make an equivalent error of two or three grams in the scale-pan.

Table.	Weight of Car and Load. (W.)	Vertical rise of Plane per 75 cm. of length. (H)	One-half sum of weights in pan. (P.)	$\frac{L}{H}$	$\frac{W}{P}$	Table.	Weight of Car and Load. (W.)	Vertical rise of Plane per 75 cm. of length. (H)	One-half sum of weight in pan. (P.)	$\frac{L}{H}$	$\frac{W}{P}$
	1461	34.0	665.1	2.205	2.197		1889	33.3	838.8	2.352	2.252
	1456	34.0	665.4	2.205	2.188		1890	33.35	842.7	2.248	2.244
1	1457	34.0	663.4	2.205	2.196	6	1888	33.35	838.2	2.248	2.252
	1462	33.95	665.4	2.208	2.197		1888	33.35	833.2	2.248	2.265
	1459	33.9	662.7	2.212	2.201		1888	33.4	838.1	2.246	2.252
	1403	32.2	602.8	2.329	2.327		1905	32.9	837.5	2.279	2.275
	1402	32.2	603.3	2.329	2.324		1907	32.75	835.5	2.290	2.283
2	1402	32.2	600.8	2.329	2.333	7	1905	33.0	836.0	2.272	2.278
	1404	32.2	605.4	2.329	2.319						
	1907	32.7	835.7	2.293	2.822		2194	32.45	952.4	2.311	2.304
	1911	32.8	838.3	2.286	2.279		2196	32.45	961.0	2.311	2.284
3	1913	32.8	835.5	2.286	2.289	8	2194	32.4	946.9	2.314	2.316
	1909	32.75	837.0	2.290	2.281		2194	32.5	947.3	2.307	2.315
	1915	32.8	834.8	2.286	2.293		2195	32.45	941.8	2.311	2.331
	1844	30.75	756.0	2.439	2.440		2200	32.2	941.0	2.329	2.337
	1841	30.6	757.6	2.450	2.430		2195	32.15	938.2	2.332	2.339
4	1844	30.7	756.8	2.443	2.436	9	2197	32.2	983.1	2.329	2.341
	1841	30.7	753.2	2.443	2.444		2197	32.2	940.3	2.329	2.336
							2201	32.2	939.3	2.329	2.343
	1850	30.05	740.6	2.495	2.498		1845	32.6	808.1	2.300	2.283
	1857	30.05	741.3	2.495	2.505						
5	1851	30.05	741.4	2.495	2.496	10					
	1850	30.00	741.1	2.500	2.496						
	1850	30.05	741.8	2.495	2.494						

AN IMPROVED METHOD FOR TIMING A PENDULUM,

BY W. H. HAWKES, ANN ARBOR, MICH.

The method of coincidence is undoubtedly the most acceptable method for the determination of time of recurrence of like phases of a body vibrating in regularly recurring periods. This method as applied to the pendulum consists in noting by some means the instant the pendulum of unknown time is in coincidence with one of known time, as the seconds pendulum, and observing the number of vibrations of both pendulums before the two are in

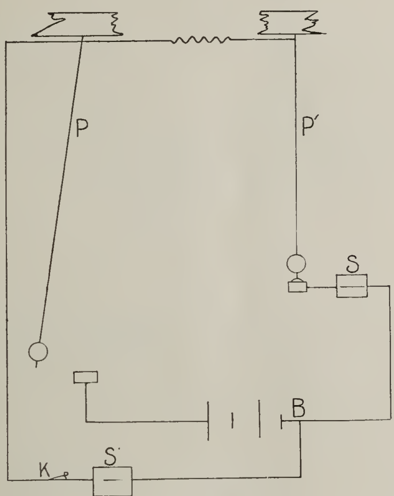

Fig. 1.

the same phase again. The means by which this coincidence has heretofore been obtained, especially in the hands of untrained and unskilled pupils, has in it a source of error because of the uncertainty which always exists where an attempt is made to locate accurately by the eye the exact position of a moving body at a particular instant of time, even where the error is much reduced by the use of the telescope to cut down the field of vision. If, however, the particular swing of the unknown pendulum which is in coincidence with the seconds pendulum is in some way distinguished, the chief difficulty is overcome.

This is accomplished in the following manner:

The two pendulums, known and unknown, are connected (as shown in Fig 1*) in the same battery circuit with a sounder or marker of some

* Owing to a slight inaccuracy in the engraving, the horizontal wire appears to be connected with the pendulums below, instead of at, the points of their attachment to the support.

sort. Each pendulum is provided with a mercury contact so that the circuit will only be closed when both pendulums are in contact with the mercury at the same time, that is, of course, the time of the coincidence. Then the click of the sounder is heard, and only at that time.

This method easily shows the difference in the time of the swing of the pendulum through a small arc and through one two or three times as large, so that the method is applicable to all parts of the problem.

This method has been tried with great success in actual laboratory practice. Eight or ten pendulums may be connected with one clock or seconds pendulum, so that a large laboratory section may be accommodated without difficulty, the pendulum of each set of students being connected with the seconds pendulum.

B =Battery.
P =Seconds Pendulum.
P′=Experimental Pendulum.
S =Sounder for Coincidences.
S′=Sounder for Seconds.
B S′ K P=Shunt circuit for ticking seconds.

APPARATUS FOR COEFFICIENT OF EXPANSION OF A SOLID.

BY L. M. PARROTT, SAGINAW, E. S., MICH.

The determination of the coefficient of linear expansion of a solid involves the measurement of a quantity so small that it must be determined with some form of micrometer screw or else be magnified by a system of levers. These two methods of measurement constitute the basis for the two general forms of apparatus in current use. This apparatus involves both ideas, but is essentially the lever type. A reference to Fig. 2, in which the framework and central part are omitted, will make clear its essential features. AB is the rod under consideration, surrounded by the jacket KL. Steam is admitted at M and it escapes at N. P and R are sockets for the introduction of the thermometers *s* and *t*. A third socket and thermometer is placed midway between A and B. These sockets are not placed directly on top of the jacket, but at an angle to the vertical, as indicated in the end view. Socket R is directly behind socket P^1. EV is a piece of plate glass, the function of which is to assure even connection at B. EF is a micrometer screw working through the solid part of the frame W. CD is a small telescope pivoted at the point O so that it may swing in a vertical plane; and rigidly fastened at right angles to its lower side is a tongue OA making

contact with one end of the rod. The frame of the part of the apparatus above described is securely fastened to a side wall. A distant scale completes the apparatus. It is fastened to the same wall in such a way that each division is retained in a horizontal plane, with the zero in the plane of the pivot of the telescope, the whole scale so arranged that its distance from the telescope may be varied.

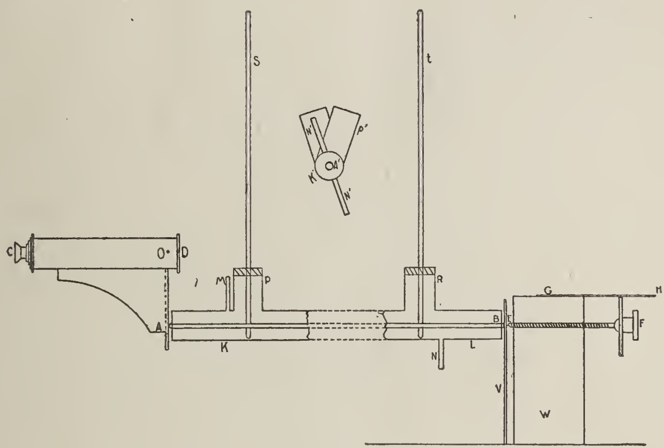

Fig. 2.

After placing the rod with its jacket in position and siphoning cold water through to equalize the temperature, as is usual in all forms of apparatus for this experiment, the pupil is generally asked to measure the initial length of the rod. In this form it is unnecessary. The micrometer screw EF serves a double purpose. It is used primarily to adjust the position of AB so that the initial reading is zero, but it also serves a second purpose. When the reading is zero, the axis of the telescope, and hence the line

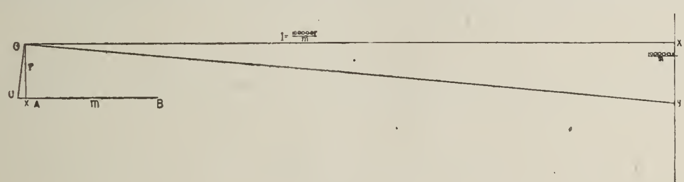

Fig. 3.

of sight, is horizontal; the tongue OA is vertical and A is a definite point irrespective of the length of the rod AB. This length then depends entirely upon the exact position of B, which is in turn determined by the micrometer screw EF, and this may be, and in this apparatus is, so adjusted that its reading, on the scale GH, is the true length of the rod.

Referring now to Fig. 3, let AB represent the original length of the rod, AU the expansion per single degree rise of temperature, O the turn-

ing point and XY the distant scale. Then XOY is the angle through which the telescope is turned for the first degree rise of temperature. Let $AB = m$, $AU = x$, $OA = r$, $OX = l$. It is evident that the triangles XOY and UOA are similar. Hence XY is proportional to the expansion x. But as m is a constant for each rod, XY is also proportional to $\frac{x}{m}$, which, by definition, is the coefficient of expansion, the constant of the ratio depending on the length l. By varying l then, we can make our apparatus directly read any number of times the coefficient of expansion rather than the expansion itself. If, for example, we wish to read one hundred thousand times the coefficient of expansion, then XY must be $\frac{100000\,x}{m}$, and from the triangles above we have $\frac{x}{r} = \frac{\frac{100000\,x}{m}}{l}$. Multiplying each member by $\frac{rl}{x}$ the unknown x is eliminated and we have $l = \frac{100000\,r}{m}$. But r is a constant value once measured always measured, and m is determined by the micrometer screw; l is then easily found, the scale XY is adjusted by means of a wall scale, and now our apparatus reads directly one hundred thousand times the coefficient of expansion. All that is then necessary is to divide the total reading by one hundred thousand times the number of degrees rise of temperature, and we have the coefficient of expansion of the rod.

A MODIFICATION OF THE GRAVESANDE APPARATUS.

BY N. B. SLOAN, BATTLE CREEK, MICH.

I think we will all agree that the principle of composition and resolution of forces is of such importance that any device which will bring the idea clearly and accurately before the student, is a welcome addition to our list of apparatus.

In presenting this piece to the conference I lay no particular claim to originality. The idea is identical with that of the Gravesande apparatus, as described in Deschanel's Natural Philosohpy, and the modifications are only such as secure ease in reading the results and a wider range to the use of the apparatus.

The apparatus (Fig. 4) consists of four wires, jointed to form the parallelogram *abcd,* and a fifth wire *ae* forming the diagonal. At the corners *b* and *d* are attached cords, extending over the pulleys x and y. The pulleys are attached to the blocks P and Q, which are jointed to the frame. This is important, for with the addition of different weights in the scale pan E and the consequent rising or falling of the parallelogram to the new position of equilibrium, the pulleys will adjust themselves so that the tension due to the

weights *m* and *n* will always be in the straight line of the sides *ab* and *ad*. To the diagonal *ae* is attached a scale made, in this case, of a thin strip of sheet zinc so that the length of the diagonal is read directly in cm. R is a protractor (also made of zinc and soldered to the side *ab*) for reading the angle formed by the adjacent sides *ab* and *ad*. The side *ab* is 20 cm. long and *ad* is 10 cm.

The experiment may be given as follows: The apparatus is adjusted so that scale pans and parallelograms are in equilibrium. A weight of 200 grams is placed in the pan *m* and 100 g. in *n*. These are constant. A weight of

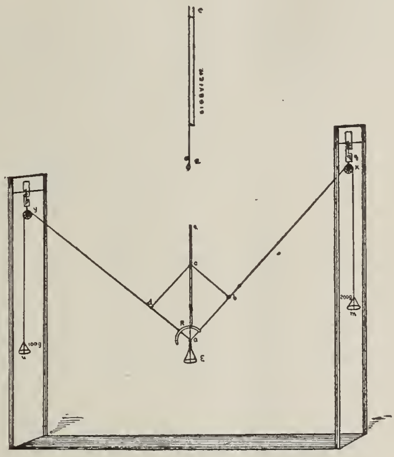

Fig. 4.

200 g. is placed in E, *ab* and *ad* are measured and the ratio of these quantities is compared with that of the weights. Then *ae* and the angle *bad* are read off. Then take a series of readings with different weights in E and make a record of the same. Then place weights in E until the angle *bad* is one of 70°, then 80°, 90°, 100°, 110°, recording each time the angle, the weight in E and the length of *ae*. With the formula $R^2 = P^2 + Q^2 + 2PQ$, cos *o*, compute R and find the difference between the computed R and R as observed on *ae*.

The following results are obtained by students:

Angle.	E.	R.	Computed R	Error.
70°	250	25	25.23	.23
80°	240	24	23.86	.14
90°	220	22.5	22 36	.14
100°	210	21	20.74	.26
110°	184	19	19.06	.06

THE CONSTANT VOLUME AIR THERMOMETER.

BY A. O. WILKINSON, DETROIT, MICH.

I claim nothing new in what I have to present. It is merely a method that I have made use of in the laboratory to show the constant relation between the temperature of a gas and its pressure. The apparatus (Fig. 5) consists of a glass flask containing dry air, made dry by a little sulphuric acid placed in the flask. This is inclosed in a tin can filled so as to cover the flask. Leading out of the flask is a glass tube bent twice at right angles,

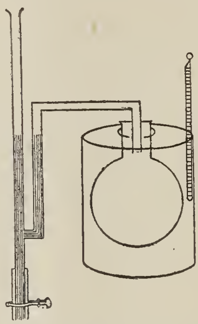

Fig. 5.

which is connected to another glass tube having a rubber tube and a pinch cock at the bottom. These tubes can be placed in front of a mirror scale. Mercury is placed in the longer arm; when the mercury is at the same height in both arms, the air, of course, is under the pressure indicated by the barometer; its temperature is that of the water.

To obtain other readings heat is applied to the can and enough mercury is poured into the longer tube to bring the mercury in the short arm to its original position, when the volume of the inclosed air is the same as the original volume. The difference in the heights of the mercury in the arms measures the increase of pressure. These results are tabulated as pressure and absolute temperature. The temperature is then divided by the pressure to show the constant relation, i. e., the temperature measured on the absolute scale varies directly as the pressure.

COEFFICIENT OF EXPANSION OF A GAS AT CONSTANT PRESSURE.

BY N. H. WILLIAMS, DETROIT, MICH.

Among the physical constants that have been made the subjects of laboratory experiments, none is more important than the coefficient of expansion of a gas. Its relation to the absolute zero and its immediate application in the volumetric work of the laboratory make it of peculiar interest and importance to both the physicist and the chemist. Elaborate experiments have made known to us the value of this constant with considerable accuracy, but a simple apparatus that will give reasonably accurate results in the hands of students has not till the present time been devised. Experiments for finding the pressure coefficient at constant volume, however, have been successful.

Nearly a dozen different pieces of apparatus have been used by the author of this article, but with little success. Mercury as a valve to enclose the air is unsatisfactory. The gas, if in contact with water, expands very irregularly, and even if corrections are made for aqueous tension, no concordant results are obtained. Methods involving only measurements by weighing have been tried; in these cases glycerine being used in contact with the gas, but still the presence of water vapor introduced a large error. Some active drying agent as a valve to enclose the air is indispensible, and sulphuric acid seems to be the only liquid available. Its vapor tension is insignificant. Its density is much less than that of mercury, and hence the pressure can be more accurately adjusted. One method in which sulphuric acid was used is of interest because it shows how important it is to exclude every trace of moisture. A long U tube an eighth of an inch in diameter was employed. A little sulphuric acid was put into it to separate the air in the two sides. Into one arm there was fitted a piston of paraffined wood. A little mercury over the piston made it perfectly air tight. As the gas expanded or contracted with changes of temperature, the piston was moved so as to keep the surfaces of the acid in the two arms at the same level. The measurements were made by putting the tube into a deep jar of hot water and observing the temperature of the water and the position of the piston after the adjustment for pressure had been made. The apparatus was then put into cold water and the piston pushed down as the gas contracted. The temperature was again observed and the length of the air column measured. These data are sufficient for calculating the coefficient of expansion. The results obtained in this way were good, but if the apparatus is put into cold water first, it will be cooled below the dew point, and traces of moisture will be deposited in-

side the tube above the piston. As the piston is afterward raised in the second part of the operation, sufficient moisture will slip by it to cause an error of ten per cent. in the result.

This difficulty is eliminated by the apparatus described below. A glass tube a little over a meter long is bent into the form shown in figure 6. The shorter arm is closed by a short glass rod fused into the end of the tube. Some sulphuric acid is put in and another tube of smaller size is put into the open end and pushed down into the acid. The displacement of the acid by this tube as it is pushed downward raises the surface. This method permits an adjustment of the level through about eight inches, thus it is always possible to bring the surfaces of the liquid in the two arms to the same level and produce atmospheric pressure upon the enclosed gas. A metal band CC is arranged to slide upon the tubes. It is fastened to a wire, R, so that it may be adjusted to mark the liquid surface. The apparatus is put into cold water in a deep cylinder of glass and the level of the liquid in the long arm is adjusted to that in the short arm by moving the inner tube T up or down. The metal band is then brought to this level and the temperature of the water noted. Next the apparatus is placed before the mirrored scale of a Jolly balance and the length of the air column accurately measured. The operation is then repeated with water at a temperature thirty or forty degrees higher.

If V_1 and V_2 represent the two volumes and t_1 and t_2 the corresponding temperatures, we shall have the two equations $V_1 = V_0(1 + at_1)$ and $V_2 = V_0(1 + at_2)$, in which V_0 is the volume of the gas at zero degrees C, and "*a*" the coefficient of expansion. Eliminating V_0 between these two equations and solving for "*a*," we have

$$a = \frac{V_1 - V_2}{V_2 t_1 - V_1 t_2}$$

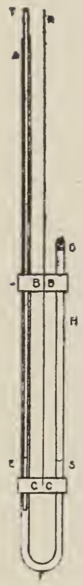

Fig. 6.

The following results will give an idea of what may be expected of the apparatus. None of them show more than one per cent. of error. .00002 is added to each result as found by the formula to correct for the expansion of the glass: .00366, .00365, .00363, .00368, .00366, .00363, .00364, .00366, .00368, .00366, .00366.

The following results are obtained by one of the laboratory sections. The error in two cases is greater than one per cent. .00365, .00366, .00371, .00370, .00366, .00373, .00353, .00368.

A MODIFICATION OF HARE'S METHOD FOR DENSITIES OF LIQUIDS.

BY DE FORREST ROSS, YPSILANTI, MICH.

Fig. 7 represents an apparatus for determining the specific gravity of liquids by the Hare's method. It consists of a piece of board H about 100 cm. long by 15 cm. wide, rigidly fastened to a base K about 6 cm. wide, which, by being clamped to a table, supports the piece in a vertical position. 1, 2, 3, 4, 5 are test tubes 2 cm. in diameter by 10 cm. long, which contain the liquids to be tested; 3 contains water with which the other liquids are to be compared. R is a meter-stick for measuring the heights of the liquids in the various tubes by means of a carpenter's try-square.

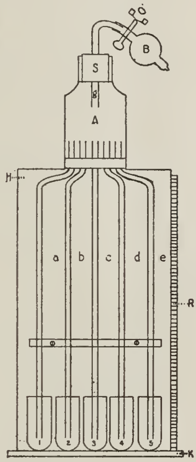

Fig. 7.

A is a bottle with the bottom cut off and fitted with a rubber stopper perforated to receive the tubes *a, b, c, d, e.* The top is closed with the rubber stopper S, perforated to receive the tube *s,* to which is attached the rubber bulb B, by means of which a part of the air in A is removed, thus causing the liquids to rise in the tubes. The pinch-cock O prevents the return of the air.

The advantages of this apparatus over that of two tubes connected by a "Y" tube are several. The thin glass test tubes permit of more accurate reading of the surfaces of the liquids. The same liquids are always in the same tubes. Several liquids may be compared at the same time with great accuracy, as the tongue of the try-square will come in contact with the tubes, thus avoiding the error of parallax and always being at right angles to the

tubes. The hand-pressure on the bulb B is a much more agreeable way, to say the least, than the mouth for removing the air from the tubes. The piece is cheap, easily made and always ready.

A MODIFIED AMPÈRE APPARATUS.

BY H. N. CHUTE, ANN ARBOR, MICH.

Supported on a stout steel wire, within a vertical rectangular helix of wire, is a series of three electrically independent rectangular helices rigidly fastened so as to turn together (Fig. 8) with their naked ends dipping into a circular trough of mercury divided into two opposite sectors of about 60° arc electrically connected to the binding posts on the base. By means of a

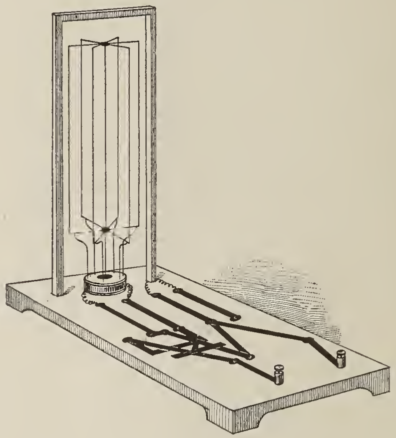

Fig. 8.

sliding commutator the direction of the current in these movable helices can be reversed, and by means of a switch the stationary rectangular helix can be placed in or out of circuit at pleasure. The revolving helices consist, each, of ten turns of No. 24 copper wire, and are carefully balanced on the supporting point. When properly arranged only two of them can be in circuit at any one time. A current of four or five ampéres will produce continuous rotation of the hexagonal helix in the earth's field with the stationary helix out of circuit. A rapid rotation is secured by holding the pole of a bar magnet near it. With the stationary helix in circuit the attraction or repulsion of parallel currents, according to the direction given the current through the movable helices, causes it to rotate very rapidly.